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ON THE ADHESION OF THE WHEELS OF LOCOMOTIVE ENGINES, BY W. R. CASEY CIVIL ENGINEER. SEPT. 1839.

Powerful locomotive engines will seldom be required for passenger-trains, and, up to this time, the quantity of freight carried over any railroad in the Union, as far as I can ascertain, falls short of 100,000 tons per annum, whilst the average, according to De Gerstner, is only 15,000 tons carried over each railroad in the country. This is about the one hundredth part of what can very well be done on a well located railway with a single track.

We may however confidently expect that railways will very soon be used for the transportation of freight on a scale sufficiently extensive to prove their capacity for this object. As yet there can be little danger in asserting, that there is not a railroad in the country, which has been located, constructed, and subsequently managed, so as to be even tolerably well adapted to the transportation of a large quantity of freight. The Reading railway will be first in the field to show the power of this new means of communication, and it would be difficult to find a better champion for the cause of railroads. On the Reading road there is, however, no ascending grade in the direction of the greatest trade, and the common 8 or 9 tons engine will easily draw 150 to 200 tons on a level—the greatest reistance offered with the admirable grades of that road; but, where inclinations of from 40 to 60 feet per mile are to be surmounted, engines of that weight are utterly inadequate to the task, whilst heavier or more powerful ones require a more substantial and consequently more costly superstructure.

The question then naturally suggests itself—cannot the power of the engine be increased without an increase of weight? which again immediately leads us to consider, what it is which limits the power of the locomotive steam engine. This is well known to be the friction, or, as it is generally termed, "the adhesion" of the wheel to the rail, which all good engines

built during the last 4 or 5 years have been able to overcome; that is, where the load was sufficiently great, to make the driving wheels revolve without causing the engine to advance. Strange as it may appear, no experiments have yet been made to determine this all important point, and the "friction of iron on iron" given in treatises on mechanics, as equal to about 1-4 of the weight, has been hitherto used in all *calculations* as the maximum, though numerous well authenticated *performances* have shown, that the ratio of the adhesion to the weight must have been much greater than this. In a pamhlet written so late as last year (1838) Messrs. Knight and Latrobe, speaking of a performance of the Stonington locomotive (p. 15,) which showed the adhesion to be equal to $\frac{1}{4{\cdot}55}$ of the weight, say "As this is greater than we have known in any other case, it is presumed that a portion of the weight of the tender was transferred to the engine etc; but performances of the engines of Baldwin and Norris on the Philadelphia and Columbia railway, long before this pamphlet appeared, go very far beyond this.

In 1836, engines built by Mr. Norris, not exceeding 8 tons in weight, drew loads equal to 400 tons on a level, which, if the weight on the driving wheels was correctly given, showed the adhesion to exceed 1-3 of the weight. Mr. Baldwin's engines have, however, since exceeded even this, and have drawn loads equal to above 700 tons on a level. Estimating the traction at 10 pounds per ton, this will require a force of 7000 pounds, and the weight on the driving wheels of Mr. Baldwin's first class engines being stated at 12,120 pounds, the adhesion must have been equal to $\frac{1}{1{\cdot}73}$ of the weight, if this did not exceed 12,120 lbs. or even adding 4000 pounds for the tender, equal to $\frac{1}{2{\cdot}3}$ of the insistent weight.

After making every reasonable deduction, it appears beyond all doubt, that the adhesion has been very much underrated, and, though this alone keeps the power of locomotives within their present range, I have never heard of a single direct experiment to determine this important law. In the edition of '31 of Wood on railroads the adhesion is stated at 1-12, subsequently it is assumed by Mr. Knight at 1-8, or "half the friction of iron on iron," which value was not determined by experiment but was merely deduced from the load; so again in the pamphlet already referred to, as late as last year, $\frac{1}{4{\cdot}55}$ is "greater than we have known in any other case."

Since writing the above, I have seen the experiments of M. G. Rennie on friction, as detailed in the 5th vol. of the Journal of the Franklin Institute, 1830, and he there shows, that there *is* an increase in the ratio with the increase of weight, the surfaces in contact remaining the same. The extreme weights in 11 experiments [p. 9,] are 1·66 cwt. and 5 cwt. per square inch, and, with these pressures, the ratios of the weights to the adhesion are respectively as 4 and 2·44 to 1. The results of the experiments are

very irregular, and, though in this particular case the ratio varies very nearly as the square roots of the weights, there is nothing to point out the law of increase, so as to enable us to continue the table with any confidence.

On the next page [10] it is stated that with 6·5 cwt. per square inch, cast and wrought iron abrade, and the friction is to the weight as 1 to 2·3. Now, as the weight on the driving wheels is generally 2 1-2 tons on each, as the friction of wrought iron on wrought iron is greater than on cast iron, as this difference is rendered the greatest possible by the parallelism of the fibres of the tire and rail, and as the surfaces in contract can scarcely be 1-4 of a square inch, it is evident, that the power required to produce motion, when the pressure is 2 1-2 tons on a surface of much less than 1 inch square, must be more than $\frac{1}{2 \cdot 30}$ of the insistent weight. It is stated, [p. 10,] that hardened steel abraded with 10 tons per square inch, but the ratio of the power to the weight is not given.

The laws of friction, are however, only applicable as long as no abrasion takes place, and this falls very far short of the case under consideration, where the pressure is often sufficient to cause even hardened steel to abrade. Still these experiments and numerous performances of the engines of Baldwin or Norris would lead to the conclusion, that the adhesion is at least twice as great as that which Messrs. Knight and Latrobe designate as "greater than we have known in any other case."

The most interesting performances of locomotives which have fallen under my observation are those detailed in the Franklin Journal of June 1839, where an engine on 8 wheels, constructed by Messrs. Eastwick and Harrison, *started*, on a grade of 27 feet per mile, a load of 265 tons, subsequently overcoming with the same load, a rise of 35 feet per mile. This took place on the bad and crooked road between Broad street and the Schuylkill bridge, where the traction must have been 10 pounds per ton on a level, and the entire force exerted by the engine equal to 6600 pounds. In this engine there are *four* driving wheels, on which the weight was 18,059 pounds, showing thus, that the adhesion was equal to 1-3 of the weight even *with the wheels coupled.* The weight on the driving wheels of Baldwin's engines of the first class, is 1-3 greater than on *one* pair of driving wheels of the engines of Messrs. E. and H., and any sudden lurch of the engine which, with the ordinary construction, will throw more than half its entire weight on one wheel, will, with these engines, be distributed on two wheels, and there can be little doubt, that an engine with the usual weight on 2 driving wheels, will be more injurious than one with twice that weight on four drivers, as arranged by Messrs. E. and H. Here is an engine which will with ease, draw 100 tons nett, up an ascent of 60 feet per mile, and which requires, on *that* inclination, a superstructure no more substantial, than is required by the lightest engines of Baldwin or Norris, on roads varying from a level to 20 or 30 feet per mile—*and this too with anthracite fuel.*

In the interesting pamphlets of Messrs. Knight and Latrobe, already referred to, those gentlemen state that the Camden and Amboy "Company is now building, and have nearly completed, an engine upon eight wheels, and having two cylinders of 18 inches diameter by a 3 feet stroke; the whole supposed to weigh 18 tons." * * * * "The adhesion upon the rails of all the 8 wheels, is to be brought into action by means of cog-wheels etc. etc. * * "This engine is designed to lead burthen trains at moderate rates of speed; but must be viewed as yet in the light of an experiment."*

It is difficult to conceive how such, in other respects, keen observers could pass by with cool indifference the most striking fact related in either of their interesting pamphlets and which, even without being completely successful, would be attended with results infinitely more important than the benefits resulting from all American improvements in railroads and locomotives united. In illustration, not explanation, it may be proper to observe, that of all the engineers and machinists with whom I have conversed for the last 2 or three years on this subject, I have only found two engineers [the machinists would not listen to it] who had given the subject that serious attention to which it is, in my humble opinion, pre-eminently entitled. One of these gentlemen, Mr. H. R. Campbell, of Philadelphia, showed me, nearly 3 years since an engine on 8 wheels and 4 drivers, which he was then building to burn anthracite coal, and which certainly bore an astonishing resemblance to the drawings of Messrs. Eastwick and Harrison's engine in the Franklin Journal, and to the advantages of which I have already alluded.

We have seen that with the eight wheeled engine and 4 wheels coupled, the adhesion was equal to 1-3 of the weight on the propeling wheels and if, with the 18 tons engine of Messrs. Stevens, we suppose the adhesion equal to only 1-4 of the weight, we shall have a machine capable of drawing 1000 tons on a level, without greater injury to the superstructure than the ordinary 8 or 9 tons engines of Philadelphia, Baltimore, New York, Lowell, etc. An eight wheeled engine, weighing ten tons, acting by the adhesion of its entire weight distributed equally on the eight wheels, will draw 90 tons nett up an ascent of sixty feet per mile, and there will be no inducement to lessen this weight, as it is only 1 1-4 tons per wheel, or the same as that on each wheel of an ordinary freight or passenger car, when loaded.

It is well known, that the rapid destruction of wooden rails is not caused so much by the natural decay of the timber consequent on its exposed situation, as by the crushing under the driving wheels of the locomotive, which destroys the lateral cohesion of the fibres of the wood and admits water, the grand agent of decomposition. Notwithstanding this disadvantage, the repairs of the wooden track of the Utica and Schenectady railroad, do not exceed the repairs of the best roads about Boston, (from 300 to 350 dollars per mile per annum, the renewal of the iron being neglected in both cases) and, if an engine of 10 tons will not be more injurious to the superstructure, than an ordinary car, it may yet appear, that this improve-

ment *alone*, will reduce the repairs and renewals of the common superstructure, below those of the best road in the Union, omitting the assistance which may reasonably be expected from Kyan's or some other mode of preserving timber.

It has frequently happened, that horse power has been used for a short time after the opening of a road, by which the nice adjustment of the rails as received from the hands of the engineers, has been little if at all affected. After the road has been travelled by the engine, however, even for a single week, with the very same cars, depressions and inequalities will be found greater, as well as more numerous than those which would be produced by the action of the *cars* only in six months or more. Timber as well as iron will bear a certain strain without the least injury, but a slight increase beyond this, produces a permanent "set" or deflection, hence, in reducing the weight from 2 1-2 to 1 1-4 tons per wheel, the relative strength of the superstructure is not merely doubled, but is increasedin a much greater ratio. This proportion will be affected by the dimensions of iron and timber, kind of wood, arrangement of parts, nature of earth, etc. etc., but as a general rule it will be greatest where most needed—for instance, when a light superstructure is bedded in clay, in a northern climate.

The distribution of the weight of the engine on eight wheels, instead of throwing 3-5 or more on 2 wheels, is therefore intimately connected with the continuance of a cheap superstructure, which has been, and will be, even with the present engines, extensively used in many parts of the country, where capital and good mechanics are scarce and timber and axemen abundant. Owing to the increased deflection of the wooden rail there will of course be a loss of power, but this, even now not very important, will be reduced one half by the distribution of the weight on all the wheels, besides which the only fear is, that full loads will only too seldom be obtained for the lightest class of engines, built on this principle, even with grades of from forty to sixty feet per mile.

I have been informed by my friend Mr. E. F. Johnson (the other engineer alluded to in a preceding paragraph) that a trial of this new engine has been made and that it appears to work well. Time and experience can however alone develope its powers, expose its defects and give unerring proof of its general and successful adoption. But supposing, what is most unlikely, that this experiment should lead to no useful result, we have still the eight wheeled engine of Messrs. Eeastwick and Harrison (or Mr. H. R. Campbell?) which is capable of drawing 100 tons nett up an inclination of sixty feet per mile, and which will be less injurious to the superstructure than the ordinary eight or nine tons English or American engine.

An extremely interesting and still more useful experiment may very easily be made with the engine of Messrs. E. & H., or still better, with that of the Messrs. Stevens. Remove the couplings so that the engine may act by the adhesion of one pair of wheels only, and ascertain the maximum

load without slipping the wheels; then couple two pair of wheels, repeat the experiment and the increase of load will show the value of the improvement of Messrs. E. & H. With the eight wheeled engine, four such experiments should be made, by which the advantages of this mode of construction would be determined with considerable accuracy, and all requisite information afforded on this vital, and hitherto much neglected principle, of working by the adhesion of more than two wheels.

The successful introduction of engines with the weight distributed equally on, and acting by the adhesion of eight wheels, would form an era in the history of railways in the United States, second only, to that which determined the general question of the practicability of locomotion by steam—in other words, that which gave its present importance to this unrivalled mode of communication.

West Haverford, Del, Co. Penn.
September 12th, 1839.

For the American Railroad Journal.

Having been employed on the Columbia and Philadelphia railway during its construction, a great many notes relative to the character and cost of the different portions of the work, accumulated in my possession.—Taking advantage of some leisure time this summer, (the first that has occurred since the completion of that work) I have arranged these notes for my own satisfaction, and have added some statements relative to the subsequent operations upon the road. The object being merely to give a correct statistical account, I have abstained from giving expression to any opinions or speculations as to the character or merits of the work. In making comparisons of the performances on different railways, I have often felt the want of correct information as to the important features of the roads in question.

Under the impression that the same might be the case with others, I have thought the annexed account might not be uninteresting to your readers. Should you agree in this opinion it is at your service for publication. Respectfully yours.

W. H. Wilson.

Columbia and Philadelphia Railway.

This railway commences at the corner of Broad and Vine streets, in the City of Philadelphia, and terminates at the burrough of Columbia on the Susquehanna river, the length being 81 6-10 miles. It has been constructed and is still owned by the State of Pennsylvania.

In the year 1827, surveys of the route were made by direction of the Legislature, and on the 24th of March 1828, the construction of the railway was authorised as a State work. The location was commenced immediately after, and early in the year 1829 the grading and bridging of 40 miles of the road were put under contract; different portions of the work were successfully contracted for, according to the yearly appropriations made

for that purpose. On the 20th September, 1832, twenty miles of single track were opened for travelling; in April 1834, a single track was completed throughout, and in october of the same year, both tracks for the entire length of the road were open for public use. Much incidental work was however done after that time, the buildings for depots, workshops, &c. being in an unfinished state and some turn-outs, farm bridges &c. not constructed.

Major John Wilson had charge of the operations on this line as Chief Engineer, from the commencement of the preliminary surveys, until a short time previous to his death in the spring of 1833, after which time the work was placed under the direction of Edward F. Gay, Esq. The following description will afford some general idea of the prominent features of this railway. From Broad street the line takes a northwesterly course passing near the Fairmount water works, and from thence runs nearly parallel to the Schuylkill river, which it crosses at the distance of about three miles from the city, the grades being undulating to conform to the inclinations of the streets which are crossed. Immediately west of the river is an inclined plane of 2805 feet in length and 187 feet in height; this plane is straight and its inclination uniform. From the head of the inclined plane, the line is continued on the dividing ridge between waters flowing into the Delaware and the Schuylkill, for about 19 miles, to a point near the intersection of the West Chester railway, where it attains an elevation of 543 feet above high tide; the grades on this portion of the road are varied and undulating, but generally ascending westward. The road now descends the northern slope of the South Valley hill into the Great Chester Valley, and after crossing Valley creek, comes to the East or Big Brandywine at Downingtown; for nearly the whole distance [about 11 miles] the descent is at the rate of 29 feet per mile. The hight of railway above high tide at Brandywine bridge is 250 feet. From East to West Brandywine, a distance of about 7 miles, the grades are generally ascending, the whole rise between those points being 121 feet. After crossing the West or Little Brandywine near Coatesville, the line ascends the Southern slope of the North Valley hill until it reaches the summit of the Mine ridge at the Gap. According to the first location, an excavation of 37 feet was required at this point, but upon removing a few feet of the surface, the material below was found to be quicksand; after losing a great deal of time, and incurring heavy expense, in efforts to work down this cutting, it was deemed advisable to raise the grade so as to reduce the depth of excavation to 23 feet; in consequence of which, the grade now stands at 45 feet per mile, descending each way from the summit for three foruths of a mile and then at 40 feet per mile for one fourth of a mile, when it meets the original inclination of 30 feet per mile. The Gap summit is 553 feet above high tide at Philadelphia. From this point the road descends, and after crossing Pequea creek, Mill creek, and Big Conestoga, enters the city of Lancaster; leaving which, it is conducted across Little Conestoga, towards the head

of the inclined plane at Columbia. This plane is 1800 feet in length and 90 feet in height; it is straight and its inclination uniform. From the foot of the plane the road continues along the margin of the river Susquehanna in front of the town, to the outlet lock and basin of the Pennsylvania Canal. It is graded along the edge of the basin, sufficiently low for the convenient transfer of articles from one mode of conveyance to the other. The passage of a law to authorize the construction of this railway by the Commonwealth, met with serious opposition, and even after the work had been commenced, it was for some time a matter of doubt whether opperations would not be suspended. Under these circumstances, it was the earnest desire of the friends of the road, that as much economy should be used in the construction, as was consistant with a due regard to the utility of the work, when completed. Previous to commencing the location, it became necessary for the Engineer to determine upon its governing principles, and in order to establish these, recourse was had to the experience gained upon works of a similar kind already in operation. It must be recolleted that this was in the year 1828, previous to the opening of the Liverpool and Manchester railway, when there were but few railways of any extent in use, and those of very imperfect construction. It was also prior to the successful use of Locomotive engines; it is true that these machines were then operating upon some of the English railroads, but their use was attended with so many objections, that very few were sanguine enough to anticipate their general adoption. After the most mature consideration of the subject, the maximum grade of the Col. and Phil. railroad was fixed at 30 feet per mile and its minimum radius of curvature at 631 feet, these being the limits to which it was thought prudent to go, with an eye to economy of construction on one hand, and the useful effect of the road on the other. The principles here laid down have been adhered to with one exception, which is the increase of grade in surmounting the Mine ridge at the Gap; the distance however for which the grade has been raised is so short, that the difference is scarcely felt by trains passing over the road. It may be proper to observe here, that in references made to this railway by companies prosecuting rival works, or by others interested in representing it in the most unfavorable light, the minimum radius of curvature is stated at 300 feet; there is a curve of this radius 7 chains in length at the termination of the road, but it is in the streets of Philadelphia, beyond the point at which the Locomotive engines are stopped and the trains separated, and ought no more to be taken into view when refering to the road, than ought the numerous abrupt curves through the Northern Liberties to be considered as parts of the Trenton Railway. The inclined planes on this road being a source of expense and delay to the transportation, every possible effort has been made to avoid them. A new route of six miles in length has been located, and is now nearly completed, by which the plane at Columbia will be dispensed with; the distance is about the same as the part of the old line to be abandoned, and the grade 35 feet per mile. Several routes have

been surveyed for the purpose of avoiding the inclined plane near Philadelphia, but as yet no alteration has been adopted by the States, two roads have been commenced by chartered companies for this purpose. The West Philadelphia railway is about 8 miles in length, its maximum grade 57 feet per mile, and its average grade 43 3-10 feet per mile; the grading of this road is principally done, but the work is now suspended for want of funds. The other route is by the Valley and Norristown railroads; the distance by Valley road is 20 1-4 miles, and then by Norristown road 13 1-2 miles, making a total of 33 3-4 miles or 2 1-8 miles more than the portion of the State road to be avoided; the maximum grade of the Valley road is 35 7-10 feet per mile, and of the Norristown 37 4-10 feet per mile; the latter road is graded for two tracks, and has one track now in use; on the Valley road the grading is partly done. On no other route yet surveyed for avoid-this plane is the grade less than 40 feet per mile.

The following is a summary of the straight lines and curves on the Col. and Phil. railway.

	Miles.	Chains.	Links.
Straight line,	56	62	54
Curve of 3782 ft. radius,		75	25
" " 1981 " "	5	24	16
" " 1513 " "		57	00
" " 1260 " "	6	16	73
" " 968 " "		8	42
" " 946 " "	6	20	04
" " 841 " "		9	67
" " 757 " "	3	61	29
" " 631 " "	1	25	95

Grading.—The width of road is 25 feet in the excavations, and by the original design it varied on the embankments from 22 to 25 feet, according to the supply of material, but at this time the top width of embankments generally exceeds 25 feet. The deepest cuttings on the line are between 30 and 40 feet, and the lightest embankment is 80 feet.

Inclined planes.—The inclined plane at Schuylkill river is 2805 feet in length and 187 feet in height; at the head of the plane is a building composed of two wings built of stone, connected by a wooden structure over the roadway. Each wing is calculated to hold a stationary steam engine of 60 horse power; only one. however, has been put up. The rope is an endless one, of 9 inches circumference when new, and cost about $2,800. The first rope used was 6 3-4 inches in circumference, cost $2,100, weighed 5 1-4 tons, and lasted about one year. The inclined plane at Columbia is 1800 feet in length, and 90 feet in height. The engine house at head of plane is built of brick, and designed to accommodate two steam engines of 40 horse power each, one of which is put up. On both of these planes double tracks are laid, and cars are passed up and down at the same time.

Culverts.—The culverts are all built of stone, and the masonry is either

hammer dressed or rubble work; they are 75 in number, with spans varying from 4 to 25 feet, and contain 31,161 perches of masonry.

Bridges.—The number of railway bridges or viaducts is 22; they are constructed with stone abutments and piers, surmounted by wooden structures, and contain 61,425 perches of masonry, and 7,212 lineal feet of wooden platform. Two of these bridges supported on small stone piers and wooden trestles, have lately been replaced by embankments. There are 33 bridges across the railway for public and private roads. The following are the most important viaducts.

Schuylkill viaduct.—The superstructure is composed of wood, with four distinct trusses, formed of arch pieces, king posts, and braces, being a modification of Burr's plan. The whole width from out to out, is 49 ft. 8 inches, which admits of three separate passages, two of 18 1-2 feet each, in the clear, and one of 4 ft.; the latter is intended for foot passengers, one of the former for two railway tracks, and the other for common carriages. The spans are seven in number, and their lengths in clear, between the piers are as follows; two of 122 feet each, three of 135 ft. each, and two of 137 ft. each. The eastern abutment and four piers are founded upon solid rock; the remaining abutment and piers, upon hard gravel. The masonry is coursed and hammer dressed. Five of the piers were built in the river, and required coffer dams; one of which stood in 26 feet depth of water. The whole length of wooden platform is 1,045 feet, and the number of perches of masonry 19,100. The height of bridge floor above the usual water line, is 38 feet. The total cost including painting inside and outside, was $133,946 57.

Valley Creek viaduct consists of 4 spans, each 130 ft. in clear between the piers. The piers are built of rubble masonry, and vary from 56 to 59 feet in height. The original structure was on Burr's plan, having two trusses with a clear width of 18 1-2 feet, and cost, including stone work, $22,254 21. The wood work was destroyed recently by fire, and replaced by a lattice bridge (lowered so as to admit of the railway being carried over the top,) at a cost of $17,218 13.

East Brandywine viaduct has four spans, two of 88 feet 8 inches each, and two of 121 feet 7 inches each in the clear. The superstructure is on Burr's plan with a clear width of 18 1-2 feet. The whole length of platform is 477 feet, and the height of floor above water in creek 30 feet. Cost $17,523 20.

West Brandywine viaduct has a wooden superstructure; resting upon abutments and piers of coursed masonry with rustic faces, commonly denominated rock work. The length of the bridge platform is 835 feet, divided into six spans; its greatest height above the water is 72 feet. The whole cost of stone and wood work is $57,916 00. The plan is similar to that of the bridge over East Brandywine, except that the superstructure is lowered for the railway to pass over its top. This and the new bridge at

Valley Creek, are the only two of the principal structures, on this line, in which the usual form of roof is dispensed with.

Pequea viaduct is a single span of 130 feet, on Burr's plan, and cost $8,735 50.

Mill Creek viaduct is built on Burr's plan; the whole length of wooden platform is 550 feet, and its greatest elevation from the water 40 feet. Cost $9,273 18.

Big Conestoga viaduct is 1,412 feet in length, and is elevated 60 feet above the water. The piers are built of rubble masonry, and the superstructure is lattice work on Town's plan. Whole cost $31,503 57. The longest span of this bridge is 120 feet.

Little Conestoga viaduct.—The piers are built of rubble masonry and the wood work on Burr's plan. The flooring is 804 feet in length, and is elevated 47 feet above the water of creek. Cost $15,359 00.

Railway superstructure.—The length of road being, as before stated, 81 6-10 miles, there are 163 2-10 miles of single track; of which 6 miles are laid with granite sills plated with flat iron bars, 18 miles with wooden string pieces plated in a similar manner, 2 miles with stone blocks and edge rails, having stone sills extending across the track at every 15 feet, and 137 2-10 miles with stone block and edge rails, [having wooden sills extending across the track at intervals,] except on some of the embankments, where the edge rail is secured to cross sills of wood, supported by mud sills.

Granite Track.—The trenches are dug in the direction of the road, two feet in width, and 22 inches in depth, measuring from the level of top of sill. Broken stone is then placed and compacted in layers of 3 inches each. Upon this are laid granite sills varying in length from 3 to 12 feet, and one foot in depth and width. Holes are drilled into the stone [to correspond with the holes in the bars, and to suit the width and position of the track] 3 1-2 inches in depth, and 5-8 of an inch in diameter. Into these holes, plugs of locust wood are driven, to receive the spikes which secure the iron bars, which are 15 ft. in length, 2 1-4 inches in width, and 5-8 of an inch in thickness. The inner edge of the sills, is champered off for a width of 2 inches, and the outside is backed up with broken stone. Horse power being used on the road when this track was laid, a horse path was formed of broken stone or gravel 6 inches in depth. The average cost for one mile of this track, including the trimming and dressing off half the width of roadway was $10,179 20.

Wooden Track.—The trenches are dug across the road, four feet apart, 8 feet in length, one foot in width, and 16 inches in depth [making 24 inches to top of wooden rail.] Into these, broken stone is rammed in layers, upon which are laid sills of chestnut or white oak, 7 1-2 feet long and 7 inches square. The sills are notched to receive a yellow pine string piece 6 inches square, which is secured in its place by wooden wedges. Flat

iron bars are then spiked on similar to those used on the granite track; the horse path is also similar. This track cost $5,604 48 per mile.

The two kinds of superstructure just described, have been in use on this road about seven years, but during the last year, they have been travelled over only by a few cars drawn by horses, being so much out of order as to be unsafe for locomotive engines. The wooden sills and string pieces have become decayed, and in both cases the iron bars are constantly working loose. In many places these bars have been broken or split by the heavy weights passing over them, particularly on the stone track. It is intended to renew this portion of the road with edge rails; a short distance has already been done.

Edge rails on stone blocks and sills.—The trenches are dug in the direction of the road, 28 inches wide, and 24 inches deep, [from top of block;] at every 15 feet these are connected by a cross trench 16 inches wide. Broken stone to the depth of 12 inches, is well rammed in layers; the blocks and sills are then settled in their places by heavy rammers, and backed up to their tops with broken stone. The blocks are of granite or other hard stone, 20 inches long, 16 inches wide, and 12 inches deep; the sills are of the same material, 6 1-2 feet in length, and one foot square, placed across the track at every 15 feet; the blocks are so arranged as to give a support to the rails at every 3 feet. Cast iron chairs weighing 15 lbs., are secured to the blocks and sills, by bolts driven into cedar plugs previously inserted into the stone; there are two bolts to a chair, weighing 10 ounces each; between the stone and chair, a piece of tarred canvass is inserted. The rails are of rolled iron, 15 feet long, 3 1-2 inches deep, parallel at top and bottom, and weigh 41 1-4 lbs. per lineal yard. The rail is secured in the chair by two wrought iron wedges, one on each side, weighing 10 oz. The horse path for this track is formed of broken stone and gravel 9 inches deep. Average cost of one mile $12,568 85.

Several miles of track were laid in a similar manner to the above, omitting the stone sill, and substituting in its place two blocks, at a cost of $10,927 88 per mile. This kind of track was found so liable to spread, particularly in the spring of the year, when the ground was soft, that wooden sills have since been put in at intervals, connecting the two rails of the track.

Edge rails on stone blocks and locust sills.—This kind of track is similar to the edge rail track already described, with the following exceptions; instead of stone sills, locust are used, placed 15 feet apart on the streight lines, and 9 feet apart on the curves; to suit which, some bars were rolled in lengths of 18 feet; the stone horse path is dispensed with, the tops of the blocks and sills being level with the graded surface of road. The average cost of one mile on this plan is $13,240 92; the excess over the cost of the track where stone sills were used, is owing to a rise in the cost of iron, from $41 to $50 per ton [delivered in Philadelphia.] On newly formed embankments the following plan was adopted; longitudinal trenches were dug, 22 inches wide, and 22 inches deep; broken stone to the depth of 6 inches,

being rammed in, string pieces of white oak or chestnut were laid, 12 inches deep by 10 inches wide; these being notched to the depth of 2 inches, cross sills of the same material, 6 by 8 inches, were secured to them at every 3 feet by pins or wedges. On these sills the iron chairs, rails, etc., were placed. The trenches were connected at intervals, by cross trenches, running out to the edge of the embankment, for the purpose of carrying off any water which might collect. This description of track cost $12,905 35 per mile. This road having been designed and constructed with a view to the use of horse power, a system of turn-outs and side tracks was adopted with particular reference to that kind of travelling. Turn-outs were placed at intervals from one track to the other, and side tracks were constructed, adjacent to each of the main tracks, at the distance of one mile and a half apart, for the whole length of the road; these side tracks measured as follows; 160 feet in length parallel to the main track, and 70 feet at each end, curved to the intersection with outside rail of main track. They afforded a space of about 200 feet in length for cars, and as the cars always entered in the same direction after both tracks were completed, only one moveable switch was used. The castings were according to J. Elgar's plan, and were made under his direction. Upon the introduction of steam power upon the road, the numerous castings were found very objectionable, and useless; nearly all of them were consequently taken up, and most of the side tracks were also removed. Wherever it has since been found necessary for the accommodation of business to have turn-outs or crossings, new castings have been made use of, better adapted to the present mode of travelling.

The branches connected with this railway which have been completed for use are, the West Chester railway 10 miles in length, interseting about 22 miles from Philadelphia, and the Harrisburg railway 40 miles in length, connecting at Lancaster 12 miles from the western extremity. On the former of these roads, horse power is used; on the latter, steam power;— both belong to chartered companies. The following table exhibits the cost of the Columbia and Philadelphia railway as nearly as can be ascertained. From the commencement of the work to the time of its being opened for public use, the gross amount of the appropriations for purposes of construction could easily be obtained; but since that period various sums have been appropriated yearly to this road, some of which properly belong to the item of construction, while others have been applied to objects not connected therewith.

All the documents relating to this subject have been carefully examined and the result is believed to be as correct as can possibly be obtained.

TOTAL COST OF COLUMBIA AND PHILADLPHIA RAILWAY.

Grading,	$649,158 69
Culverts,	74,113 94
Railway bridges or viaducts,	327,695 80
Road and farm bridges,	42,055 00
Fencing,	65,410 86

Railway superstructure,	2,181,156 25
Buildings and machinery,	111,787 12
Engineering and superintendence,	133,934 31
Damages,	54,833 29
Repairs,	42,451 76
Incidental,	11,980 18
Alteration to accommodate the city of Lancaster,	60,000 00
	$3,754,577 20

Cost when the road was open for use in 1834; after which, the following additional expenditures were made.

Locomotive engines,	327,203 41
Additional buildings, turn-outs, &c.,	37,511 16
Retained per centage on old contracts,	5,134 08
Engineering,	4,741 25
New ropes at inclined planes,	11,584 34
Embankment at Maul's bridge,	1,796 34
Renewal of wooden track,	18,907 48
Rebuilding Valley creek bridge,	17,218 13
New road to avoid Columbia inclined plane,	118,123 53
	$4,296,796 92

The following particulars in relation to the working of the Columbia and Philadelphia railway, are compiled from the annual reports of the officers of the road, up to October 31st 1838, the date of the last report.

	Road expenses.	Motive power expenses.	Road tolls.	Motive power tolls.	Total expenses.	Total tolls.
	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.	$ cts.
From commencement of travel, to Oct. 31 1835.	41,973 13	55,246 27	185,560 67	43,790 55	97,219 40	229,351 22
From Oct. 31 '35 to do. '36	75,311 32	184,878 84	173,837 12	90,969 12	260,190 16	264,806 24
" " '36 " '37	59,024 95	114,859 76	211,324 16	137,338 67	173,884 71	348,662 83
" " '37 " '38	44,033 23	133,820 90	233,588 75	164,052 74	177,854 13	397,641 49
	220,342 63	488,805 77	804,310 70	436,151 08	709,148 40	1,240,461 78

All the cars used on this road belong to individuals or companies, but the motive power is furnished by the State, except in the case of the West Chester cars and some few others, which are drawn by horses. Every thing connected with the management of the motive power is entrusted to an officer styled "Superintendant of motive power;" the repairs of the road are attended to by a Supervisor; these officers are independent of each other, appoint all persons employed under them, and report annually to the Board of Canal Commissioners on the state of their respective departments. There are five offices for the collection of tolls, the incumbents of which are appointed by the Board of Canal Commissioners. Separate accounts are kept by the collectors, of the tolls received for the use of the road, and for motive power; the latter constitutute a fund, out of which all expenses in that department are paid; for the repairs of the road, yearly appropriatons are made by the Legislature.

The rates of toll for the use of the road vary from 6 mills to 4 cents per ton (of 2000 pounds) per mile; there are 12 different rates, the average of which would be 2 cents per ton per mile. The lowest rates are for coal, stone,

iron ore, vegetables, lime, manure and timber, and the highest are for dry goods, drugs, medicines, steel and furs. On the United States Mail, the toll is one mill per mile, for every 10 pounds; on every passenger one cent per mile. In addition to these rates, a toll is levied, of one cent per mile on each burthen car, two cents per mile on each baggage car, and on every passenger car, one cent per mile for each pair of wheels. The motive power toll is, for each car having four wheels, one cent per mile, for each additional pair of wheels five mills, for each passenger, one cent per mile, and for all other kinds of loading, 12 mills per ton [of 2000 pounds.] The owners of cars now charge $3,25 for every passenger, and $7 50 for every ton of merchandize conveyed the whole length of the road, they paying all tolls: which is at the rate of 4 cents per mile for a passenger, and 9 14-100 cts. per mile for a ton of goods. Taking the length of the road at 82 miles, the average number of passengers to an eight-wheel car at 30, and the load of a four wheel burthen car at 3 tons, we have the following results;

Road toll on an eight wheel car,	4	cents	per mile
" " 30 passengers,	30	"	"
Motive power toll on car,	2	"	"
" " 30 passengers	30	"	"
Total toll for 30 passengers	66	"	"

or 2 2-10 cents per mile for each passenger, leaving 1 8-10 cents per mile to the owner of the car for every passenger.

Road toll on a four wheel burthen car,	1	cent	per mile
" " three tons of dry goods,	12	"	"
Motive power toll on car,	1	"	"
" " three tons of goods	3 6-10		"
Total toll on three tons of dry goods	17 6-10		

or 5 86-100 cents per ton per mile, leaving 3 28-100 cents per ton per mile to the owner of the car.

In making comparisons between the working of this and other railways, the error has generally been committed, of taking the motive power expenses [given in the reports of the State officers] as the whole cost of transportation; it must be recollected, that the State merely furnishes the moving power; the owners of cars have to provide their own workshops, and depots for receiving and depositing goods; they are also obliged to send agents with their cars, and have to take the risk of all accidents. The duty of the State agents who accompany each train, is to rgulate the motions of the train, and to see that proper returns are made to the collectors, of the passengers and freight conveyed.

DETAILS OF MOTIVE POWER EXPENSES FOR THE YEAR ENDING OCTOBER 31ST, 1838.

Expended at workshops,	$14,102 05
" " inclined planes,	16,942 90
Superintendant, clerk, and car agents,	8,022 00
Car inspectors,	1,196 00
Conductor of State cars,	407 50
Engineers of locomotives,	10,786 00
Firemen,	6,662 87½
Watermen,	6,825 00
Woodmen,	8,212 22
Wood,	27,889 33¾
Coal,	10,732 67½
Materials for engines,	20,720 91¼

Oil,	6,568 85
Miscellaneous,	852 62
	$139,920 94
Add amount of debts contracted,	5,600 00
	145,520 94
Deduct stock on hand, fuel, iron, oil, &c.,	11,700 00
	$133,820 94

During the same year, the number of passengers conveyed, was 103,336 way and through, equal to 75,612 through; the number of tons of freight transported was 87,180, and the whole number of miles travelled was 260,400.

LIST OF PERSONS EMPLOYED IN MOTIVE POWER DEPARTMENT.

Superintendant of motive power, at	$4 00	per day.
Clerk,	2 00	"
2 car inspectors, each,	2 00	"
Manager between Philadelphia and inclined plane,	2 50	"
4 agents for passenger trains each,	2 00	"
5 " " burthen " "	1 50	"
Conductor of State cars,	1 25	"
Master Machinist,	4 00	"
2 Foremen of workshops, each,	2 00	"
18 Machinists, pay varying from 1 00 to	2 00	"
9 Smiths, " " " 1 50 to	1 92	"
9 Assistants, each,	1 25	"
Engineer of stationary engine at workshop,	1 16	"
Watchman,	1 16	"
2 Managers at inclined planes, each,	2 50	"
2 Engineers " " "	2 00	"
2 Firemen " " "	1 25	"
2 Riggers " " "	1 50	"
11 Signal men, and assistants, "	1 25	"
26 Engineers of locomotives, "	2 00	"
33 Firemen " "	1 25	"
19 Watermen, "	1 00	"
33 Woodmen, "	1 00	"

The superintendant in his report dated October, 1837, states as follows: "The heavy locomotives now used for the transportation of freight, are capable of drawing thirty-five cars, each with a load of three tons, or one hundred and five tons, exclusive of the cars, engine, and tender. If their weight be added, the whole will be one hundred and ninety tons" "The average number of cars to each engine, actually hauled during the season, falls far short of the number just given; this is owing to the irregularity and decrease of business which prevailed, and to the rule, which for the accommodation of the trade was adopted, of starting a train whenever one of sufficient size to justify the expense had accumulated, without delaying, and increasing the expense of the transporters by waiting for a full one."

The number of locomotive engines on the road at the date of the last report was thirty-six, of which, twenty-seven were in good order. The daily duty of the engines is to run from the head of one inclined plane to the head of the other, a distance of seventy-seven miles; between the foot of the Schuylkill plane and Philadelphia, a distance of three miles, two engines are generally kept employed in taking the trains to and fro: form the Columbia plane to the canal basin, horse power is used, the distance being only one mile.

Materials for engines, 10,732 67½
20,720 91¼

ADVANTAGES OF COMPRESSED PEAT, OR TURF, AS A FUEL FOR STEAM ENGINES, AND IN THE REDUCTION OF IRON ORE.

From a communication addressed to the London Journal of Arts, Sciences, and Manufactures, by C. W. Williams, it appears that by a compression of the upper portions of peat or turf bogs, and working the condensed material, a compact fuel may be obtained, surpassing, in strength and other good qualities, the best coke obtained from bituminous coal.

The following extract presents the results of the experiments:

In pursuing the inquiry as to the manufacture of turf coke, I fell naturally into the common error of taking the lower portions of the bog in preference to those nearer the surface; and from this circumstance, that the latter, on account of their lightness, appeared wholly unsuited to the purpose; while the former, from their greater comparative density, seemed alone available, in producing a coke which could stand the blast. From the lower strata a sufficiently dense coke could be formed, by the aid of suitable coking stoves, but it was found to be so impure, and impregnated with so large a proportion of incombustible and deleterious matter, as to have an injurious effect on iron, from an acid which it was supposed to contain. From the upper strata, and particularly where they were composed of bog moss, which had made but little progress towards decomposition and solidification, I obtain an exceedingly pure carbon, giving a very small per centage of useless, and no injurious, matter. This upper portion of the bog, however, was of so light and porous a texture, and so apt to re-absorb moisture, by which its heating properties were much reduced, that it would scarcely repay the labor of cutting and saving, even for domestic fuel, while the lower strata, on the contrary, often approached the solidity of coal. This superior density had been acquired, in some degree, by the decomposition and consequent solidification of its vegetable fibre, but still more, by the consolidation, through ages, from the pressure of the superincumbent mass, often to the depth of twenty or thirty feet. But this great density, valuable as it may be, had been obtained at the expense of its purity and heating properties, by the addition of many heterogenous and incombustible substances; and which, *pro tanto*, and without reference to their chemical effects, deteriorate its calorific power and usefulness as a fuel.

I may here observe, that I have burned the compressed peat coke, which forms the subject of the following analysis, in a small room, in a stove resembling Joyce's stove, standing on the table, for four days and nights successively, during which it was never extinguished, and, without any perceptible unpleasant smell, or other annoyance.

Now, having thus ascertained that the upper and lighter portions of the bog had the greatest purity and heating power, weight for weight, the difficulty presented itself of combining density with purity, and which in the natural state do not co-exist.

In this I have completely succeeded, having obtained a coke, from the lighter portions of the bog, possessing not only double the density of wood charcoal, and equal to that of coal coke, but possessing that purity which is so essential in the working of iron. To ascertain the relative values of the compressed peat, and peat coke, as compared with coal, coal coke, and charcoal, I had a very accurate analysis made by the able experimenter, Mr. Everitt, and whose report I here subjoin:

Report of Experiments on Pressed Peat, and on Coke made therefrom.

DENSITY.—The density or specific gravity of water,	1000
Compressed peat, the the thinest and hardest pressed,	1160
Ditto, the thicker, or less pressed,	910

Peat coke, the thinnest or hard pressed,	1040
Ditto, the thicker or less pressed,	913
The resin fuel,	1140
The resin alone,	1110
The hardest and dry woods, such as oak, ash, elm, vary from	800 to 885
And the lighter woods, such as poplar, pine, &c., from	383 — 530
Charcoal from hard woods, varies from	400 — 625
Coals vary from	1160—1600

Hence we see that the hardest compressed peat is denser than the hardest wood, in the relation of 1160 to 885; and compared with some of the lighter wood, nearly double. Further, that the coke prepared from the hardest compressed peat, is nearly double the density of ordinary charcoal. In common practice, it is reckoned that 100 lbs. of charcoal occupy the same space in a measure as 200 lbs. of coke. The peat coke would, weight for weight, occupy the same, very nearly, as common coke.

Calorific Power.—The next point of investigation was the calorific power, as compared to coal, common coke, and charcoal.

The usual method of making assays of this kind, is to burn weighed quantities of the respective fuels, and endeavor to ascertain how much water each respectively will raise a given number of degrees, or convert into vapor. But experiments of this sort, unless made on a very large scale, cannot lead to any comparable results. It is given in Berthier, (Essais par la veie secho, vol. i., p. 289,) as being the result of accurate experiments, that a given weight of charcoal will raise 78 times its own weight of water from 32° to 212°, or boil off in vapor 11 8-10 its weight: which data do not differ materially from the results obtained on a large scale, by J. Parkes, [see his paper in the "Transactions of Civil Engineers," vol. ii., p. 161.] Now we know, from actual trial, that weighed portions of coke, charcoal, &c., used under stills and boilers, holding only from 5 to 10 gallons of water, will not produce 1-10 of this effect. I am here convinced of the utter futility of trusting to any such experiments on a small scale, with the view of having any thing like an approximation to the true relative values of fuel; even in the best constructed calorimeters, where only a pound or so of the fuel is consumed, it is very difficult to command uniformity through any two experiments. I was here induced to adopt the method recommended by Berthier, in his work, vol. i., p. 228, in order to obtain the relative values of these fuels.

It is assumed, from the result of almost all experiments, that the absolute quantity of heat generated, during the combustion of any fuel, is in exact relation to the quantity of oxygen consumed on entering into combination: hence in order to ascertain the relative calorific powers of fuels, it is only necessary to ascertain the quantity of oxygen each consumes in burning.

The best mode of doing this is to mix a weighed quantity of the fuel with a slight excess of litharge, [oxide of lead] and find what quantity of metallic lead is reduced. It is to be remarked, that this method cannot be applied to such fuels as contain any volatile matter, from Berthier, [and which also agreed with some trials made by me on the same substances.]

10 parts of pure carbon will give of lead	340 grs.
10 parts of good wood charcoal, from	300 to 323
10 parts of dry woods, from	120—140
10 parts of good coke, from	260—285

It may be here remarked, that assuming the principle, which is the foundation of this mode of assaying, to be correct in practice, it is susceptible of

great accuracy; for, as every *single grain* of carbon produces 34 grains of lead, any error in estimating the lead is reduced to 1-34th in estimating the carbon.

The following results are averages of two, and sometimes three, experiments on the same fuel; and in many cases the metallic lead in two consecutive trials did not differ more than 2 grains, which corresponds to only 1-17th of a grain of pure carbon.

10 parts of the peat coke—this was picked surface peat—gave	277
10 parts of peat coke, lower strata,	250
10 parts of the pressed peat,	137

The resin fuel, containing so much volatile matter, could not be tried in this way; and its calorific value could not be ascertained from the difficulty of arriving at any satisfactory result, except on a large scale.

The above numbers represent the relative quantities of heat which can be produced by the same quantities of each of the fuels; and in cases where quantity of heat alone is the consideration, these numbers will also represent their relative values.

But intensity of heat is often of more consequence than quantity; and intensity depends very much on the density of the fuel. Thus, charcoal can never produce so high a heat as coke; and, in this respect, the denser part coke and common coke are about equal. These comparisons are quite irrespective of any foreign matter being present which may be injurious to the quality of iron, where the fuel is used for reducing the metal from its ore, or for working iron by fire generally, or when it is used under iron boilers for generating steam.

To see how far it was probable or not that the peat coke contained matter likely to act injuriously in this respect, like some coke, portions were burnt in a variety of ways, when no sulphurous acid smell could, in any case, be perceived; sulphur, or metallic sulphurets, are the usual ingredients in common coke, to which their corrosive effects on iron boilers is to be attributed; and such coke, during burning, always gives very perceptible quantities of sulphurous acid gas.

As the nature and quantity of ash is sometimes of importance, I have also investigated these points with great care.

An average of two experiments, where 1000 grains of peat coke [made from the surface peat] were burnt till all carbonaceous matter was consumed, gave 5-100 for the quantity of ash of a light buff color.

100 grains of such ash cantain common salt,	3. 5
Silica—sand and silica combined,	15. 0
Sulphate of lime,	22. 5
Carbonate of lime,	43.25
Magnesia and carbonate of magnesia,	15.00
Alumina,	0.75
	100.00

The ash contained no carbonate of potassa, and is remarkable for the large quantity of magnesia present.

From my trials I am of opinion,—1st, That the peat coke examined by me contains nothing which would, during the burning, be more injurious to iron than wood charcoal or the best coke—whether it be used to work iron, or under boilers for the generation of steam.

2d. That it is equal to the best coke, weight for weight; in heating power, a little inferior, weight for weight, to wood charcoal, where quantity of heat is the only consideration; but where bulk of stowage, and high intensity of heat are important considerations, it is superior to wood charcoal.

London, Jan. 18, 1839. THOMAS EVERITT.

The above analysis was made on turf from Lancashire; but, from other experiments, I find the turf from many of the bogs in Ireland exceeding it in purity, and containing a much smaller proportion of incombustible matter.

In considering the forgoing report and analysis, the great density of both the peat and peat coke, though produced from the lighter portion of the surface turf, is remarkable; the compressed peat being 30 per cent. denser than oak wood, and double that of the lighter woods, while the coke is double the density of charcoal, and on a par with coal coke.

I may here add, that this density, which is so valuable where intensity of heat is an object, may be still further increased, with little additional expense.

This being the first time that the results of the litharge test, as applied to turf coke, has been communicated in this country, the value of which Berthier, in his elaborate and admirable essay on combustible bodies, has fully established, I may be permitted to say, that its accuracy, and the small amount of practical error to which the process is liable, as shown by Mr. Everitt, gives it a high claim to our attention, although to persons not familiar with the nature of chemical tests, it may not be so self-evident. We here see that the extraordinary attraction which carbon has for oxygen, and the power which it thereby exercises of de-oxidizing metallic oxides, renders the litharge test the most suitable for determining the absolute purity and calorific powers of the various cokes, at least on a small scale. The carbon, under a high temperature, uniting with the oxygen in proportion to its calorific powers; while the lead, being thus deprived of that which is essential to its state of oxide, is precipitated in its pure metallic form, the relative weights so thrown down, representing the true combustible values of the several cokes.

It will be observed that Mr. Everitt, in stating the quantity and intensity of the heat given out by peat coke, adds, that these are irrespective of the presence of any foreign matter which may be injurious to the iron. Now, we know that many foreign substances do enter into the composition of coal and coke, and do exercise a very injurious influence over iron and steel in the furnace and forge. In this respect, the importance of the peat coke becomes apparent; iron is not only sooner brought by it to a welding heat, but it is found to work softer, and with less of that scaling which is so injurious, particularly in the operation of welding.

These facts I have proved both in the furnace where large boiler plates are heated, and in the operations of the forge where even the worst iron was improved in quality.

It is not an unimportant consideration that peat coke may thus be produced from that portion of the bog which has ever been rejected as a domestic fuel, when a denser kind is to be obtained. Again, that it is precisely that description of turf which most abounds in Ireland; and in most of the large bog districts has hitherto been regarded as an absolute incumbrance, alike unfit for fuel, and for conversion to agricultural purposes. This arises from its extreme porousness and levity—its being so far removed from that decomposition which is essential to the vegetative functions of all soils, and also to its susceptibility of the extremes of excessive moisture and excessive drought—overcharged in wet seasons, and amounting to a mere *caput mortuum* in dry ones.

The resin fuel, alluded to in the foregoing report, is an artificial coal formed by a union of this peat coke and bituminous matter up to the point of saturation. Of the uses and properties of this fuel, as well as of other advantages derivable from the application of peat, I shall, with your permission, on a future occasion submit to your consideration.

C. W. WILLIAMS.

MEMOIR OF LIEUTENANT COLONEL B. AYCRIGG ON THE SUBJECT OF THE LIGHT HOUSES AT BARFLEUR AND OSTEND.

(Continued from page 136.)

This splendor, although gratifying to the visiter, is of but little consequence in a work seen by few, except in its effects; but its practical importance is obvious, when we learn that a single lamp, with the consumption of one kilogramme of oil per hour, or one American gallon in four hours and ten minutes, will, from the mirrors, produce a constant light that can be seen at the distance of 5 French leagues, or 12 1-2 miles, and an intermitting light every half-minute that can be distinguished 12 leagues at sea, and even at times, when the direct rays are intercepted by the rotundity of the ocean, rendering the position of the light easily distinguishable, from a flash in the atmosphere, as the rays, concentrated on a small area, come in the direction of the observer.

Whether the distance of 12 leagues, at which it has been stated to the writer that the light can be seen, are French, statute, or nautical, he does not recollect; probably the latter, as it came from a seaman. These distances would be, respectively, 30, 36, and 41 1-2 statute miles; while, supposing the observer to be 140 feet above the surface, he could only see the direct rays at the distance of 33 1-2 miles, if we neglect refraction; but, allowing one-fifth of the average horizontal refraction for heavenly bodies, the rays might be seen the full distance of 12 nautical leagues, provided the light be strong enough.

As to the strength of the light, its intensity is much increased by being concentrated on a small portion of the horizon, in place of being scattered, and thereby weakened, in proportion to the square of the distance. According to the recollection of the writer, [although it was not timed by the watch,] the light is not seen for more than one-fourth of one of the periods, and the full light much less. If this be taken as the measure of the angle, we shall find the light sixteen times as strong as it would be without the lens, or as distinct at 41 1-2 miles as the naked lamp would be at 2 6-10 miles. But a lamp of this size could be seen much farther than 2 6-10 miles, and, consequently, without taking into consideration the greater intensity of the light near the axis, but making every allowance for the loss from the joints of the lenses, or a greater angle than the one supposed, there remains but little doubt on the mind of the writer that the twelve leagues mentioned were nautical, and the distance consequently 41 1-2 miles; and moreover, that under peculiar circumstances of the atmosphere, when the refraction is unusually great, the light would be visible still farther.

When seen by the writer, while passing at about twelve miles distance, it presented the appearance, not of a star or point of light, but of a brilliant red ball of fire, with a very sensible diameter.

The writer is not informed as to the first cost, but the current expense is a mere trifle. These considerations are, however, of less consequence than its utility; and, in this respect, it is generally considered by navigators to be the best light along the British channel, not even excepting the famous Eddystone, which is rather remarkable for its difficulty of construction and firmness in withstanding the shock of the waves than for the brightness of its light.

Details and measures.

The column is 72 metres or 236 feet high from the base of the pedestal. The shaft is 27 feet diameter at the bottom and 18 feet at the top. A hollow cylinder is left in the centre, surrounded by 367 stone steps, commencing at the base and ending at the top. Through this cylinder the mate-

rials used in the construction were raised; and when the work was finished, a part of the cylinder was cut away to leave room for the keeper's sleeping apartment. Above this, is a thick arched stone floor, in which the shaft is placed, that supports the frames, and the lenses and mirrors. On the top of this shaft stands the lamp, while an extra lamp is kept in readiness, to be used in case of accident to the former, or derangement of its clock-work, to supply the oil. At about four feet below the lamp is the interior platform surrounding the shaft. No one is allowed to enter this place except the keeper and the engineer who has the supervision of the work, and in case of any derangement, the keeper is obliged to call on the engineer, and is not permitted even to touch the adjusting screws of the mirrors. At Ostend, however, the keeper, who was a much more intelligent man, attended to every thing.

Nearly the whole of the iron is of the same size. The frame of the interior cage for the mirrors, including the diagonal braces, the uprights, the supports of the interior platform, the lower ring on a level with the ring at the bottom of the lenses, the upper ring on a level with the upper ring of the lenses, the arched ribs, on the top of the cage, also the frame of the lenses surrounding the glass, the frame that carries the lenses, including the diagonals, the curved uprights, and the three rings are all made of iron 1 3-4 inches broad by 5 lines or 5-12 of an inch in thickness, and in all cases laid with its edge to the light. Both frames, the one revolving with the lenses, and that which remains stationary with the mirrors, are composed of eight similar parts, having all the rings divided into eight segments, and having eight diagonals and eight upright bars.

The upright bars of the inner cage pass within one inch of the frames of the lenses, and two opposite bars are connected on top by an electrical rib, reaching to the top of the window. The rings belonging to this frame coinciding in height with the rings above and below the lenses, and concentric with them, are constructed, in the same manner as the rings at the top and bottom of the uprights of the lens frame, having near the ends of each segment a flange at right angles to the flat side of the ring, so that when the ring is formed by bringing the ends of the segments together, there is an open mortice left for the end of the bars, the cheeks of the mortice receiving the end of the bar, when a screw-bolt, passing through the whole, fastens the bar to the ring, and at the same time holds the segments together. The ring at the top of the lenses not being connected with any bar, but merely screwed to the tops of the frames around the lenses, has the flanges immediately on the ends of the segments.

Attached to the inner cage are two rings of round iron, 7 1-6 of an inch in diameter, one on the inside and the other on the outside of the upright, so arranged as to receive the adjusting screws of the mirrors. These mirrors are of plate glass, set in brass backs and sides; they are one French foot [or 13 inches] long. They have each one adjusting screw in the middle, at the back, and one at each side, at 2 1-2 inches from the front. They are 4 3-4 inches beyond the range of the outside of the lenses. There are 4 between each bar, or 28 in a ring; the 4 on the land side being omitted, leaving a space below the lenses through which the keeper enters into the interior. They are as large as they can be made, so as to leave room for the adjusting screw at the sides; they vary in width according to the angle that they make with the vertical, and, by means of the adjusting screws passing into the wire, are regulated, so that the eye, placed in the position to be occupied by the lamp, sees the line of the horizon in the middle of the mirror, and consequently, in such a position that the light from the lamp will be reflected to the horizon.

The length of the mirrors being fixed, the vertical distance from one to the other must be such that no light is lost between them,

Above the lamp is placed a chimney to carry off the smoke, having the base of the cone out of range of the light from the lamp to the upper mirror.

The outer end of the 4 lower rings of mirrors all project the same distance, or 4 3-4 inches beyond the lenses. The first ring above the lenses is at the same distance beyond the lens, and the ends of the rest form a curve above, as will be seen from the accompanying plan and tabular statement of heights and distances. The wheels upon which the lens frame rolls are 6 in number, and 5 3-8 inches diameter. The friction-rollers below are 3-4 inch wide and 2 1-2 inches diameter, and are held in a ring with two open mortices, or tongue and jaws, that it can be taken off at pleasure. This ring is attached to the upper wheels.

Should it be thought a defect in point of firmness that the frames are divided into a great number of pieces, the necessity will be apparent, when the narrow passages through which they must be brought to the place required are taken into consideration.

The frame in which the lens is put by the manufacturer to hold the different pieces together, is made of the same sized iron as the two frames, or 1 3-4 inch by 4-12 of an inch; the exterior dimensions on the front are 34 inches high and 14 1-2 inches wide, and thence radiate to the centre, so as to fit close when placed side by side.

The plano-convex lens in the centre is 11 inches diameter.

There are 16 windows, 10 feet 6 inches high in the clear, composed of 5 panes of plate glass, the top and bottom being divided by a vertical strip in the centre. The width of the middle pane is 31 inches, and the frame is of iron 1 1-2 inch thick.

The following tabular statement of heights and distances corresponding, will give all the details of the measures, and from which a plan can easily be made to a working scale to supply the place of the accompanying miniature, which in some places is a little forced, in order to make the parts more distinct.

N. B. The first column gives the heights above or below the centre of the flame; those below having the negative sign. The second column gives the corresponding distances from the centre measured horizontally.

Lamp.		
0		centre of flame.
—3	1-2	inner wick.
—3	11-12	2d wick.
—3	1 1-3	3d wick.
—3	1 3-4	4th or outer wick.
—6 1-2	4	top of body of lamp.
—14 1-2	4	bottom of body of lamp.
Shaft.—This should not be of wood above the platform.		
—97 7-8	6 1-2	re-entering angle at shoulder.
—97 7-8	12	salient angle at shoulder.
—140	12	at floor of masonry.
Inside frame for mirrors.		
66 1-2	0	top of ribs joining in centre.
19 1-12	31 7-8	inside of flange at top.
19 1-12	33 5-8	outside of flange at top.
17 1-3	33 5-8	top of ring; thence the opposite bars are connected by a semi-eliptical ring rising to 66 1-2
17	33 5-8	bottom of ring.

15 1-4	33 5-8	bottom of flange.
—17	33 5-8	top of ring.
—17 1-3	33 5-8	bottom of ring.
—19 1-12	33 5-8	bottom of flanges. N. B. This ring is not perfect, but merely segments, with a single flange on the lower side, that are laid between the upright bars, and bolted against them.
—48	33 5-8	top of ring, and bottom of platform, not shown in the draught. Thence diagonals to the shaft.
Revolving part.		
19 1-2	35 5-12	top of flange inside.
19 1-12	37 1-6	top of flange outside.
17 1-3	37 1-6	top of the upper ring.
17	37 1-6	bottom of the upper ring.
—17	37 1-6	bottom of middle ring.
—17 1-3	37 1-6	bottom of middle ring.
—19 1-12	37 1-6	bottom of flange.
—24 1-12	43	bar curving around the mirrors attached to the rings above and below.
—24 1-12	44 3-4	
—59 1-2	44 3-4	
—67	35 5-12	top of lowest ring.
—67	37 1-6	
—67 1-3	37 1-6	bottom of lowest ring.
—69 1-12	37 1-6	bottom of flanges.
—89 1-4	12	top of flanges at cog-wheel.
—91	13	outer corner of top of cogs connected with clock-work.
—92 1-2	13	top of wheels [6 of them] upon which the frame revolves.
—97 7-8	13	bottom of the 6 wheels, and top of shoulder.
—98 1-8	14 1-2	outer upper angle of friction-rollers.
—98 7-8	14 1-2	outer lower angle of friction-rollers.
Lens.		
0	18	centre of curved surfaces. N. B. The measures to the joints are the same, both above and below the centre.
5 1-2	35 5-12	7th, at the re-entering angle.
8 1-8	35 5-12	6th, N. B. From these points given, the front may be described from the centre at 18 inches from the centre of the lamp. These points are in the centre vertical section. The rim surrounding the lens is of iron 1 3-4 inch by 1-3 of an inch, and dimensions out to out, 14 1-2 × 34 inches.
10 1-4	35 5-12	5th,
12 1-8	35 5-12	4th,
13 3-4	35 5-12	3d,
15 1-4	35 5-12	2d,
16 2-3	35 5-12	1st,
Mirrors.		
66	21	outer end of the highest or 7th range.
58 1-4	28 2-3	6th.
49 1-2	33	5th.
43	36 2-3	outer end of the 4th range.
36	39 1-2	3d.
30	41 14	2d.
24	42	1st above lenses.
—24	42	1st below lenses.
—28 5-6	42	2d.
—37	42	3d.

Upper floor.	
—59 1-2 46	at edge near revolving bars.
—59 1-2 80	at edge near window.
—60 1-2 80	bottom.
Window.	
66 1-2 80	top of glass, at edge of frame, in middle.
66 1-2 81 2-3	top of glass, at edge of glass.
66 1-2 38 1-3	at glass in angle. The frame is 1 1-2 inch thick.
19 83 1-3	bottom of upper pane divided in middle.
17 1-2 83 1-3	top of middle pane full size, [31 inches.]
—17 1-2 83 1-3	bottom of middle pane.
—19 83 1-3	top of lower pane divided.
—59 1-2 83 1-3	bottom of lower pane.

Light at Ostend, on the coast of Belgium.

From the minute description of the complex lantern at Barfleur, the more simple light at Ostend will be readily made inteligible.

This light ranks No. 3, while that at Barfleur is No. 4, or the highest grade in use, according to the statement of the keeper at Ostend. The lamp of this has but three wicks; that has four. The height of this column is not over one-half of the other, nor is the lantern more than two-thirds the diameter. There are no revolving lenses; but the object in this case being to produce a constant light around the whole circumference of the horizon on the sea side, the mirrors above and below, and the refracting glasses between them, are all attached in a simple manner to an upright cage, or frame of iron, supported immediately on the floor. These, as usual, are omitted on the land side, and in this place the refracting glasses are also omitted, as they do not revolve as those at Barfleur. A reflector near the lamp throws this light towards the sea.

These refracting glasses are not lenses, but straight prisms, having the back plane and front surface curved towards the horizontal plane from the lamp. As these prisms lie horizontally one above the other, held in their places by the surrounding frame, the vertical cross-section, taken at any place across the glass, would present the same figure as the vertical cross section in the centre of the Barfleur lens.

This latter concentrates the light that falls upon it to a point, or small area along the horizon; while the former, not being a lens, but a compound prism, acts only in a vertical direction, and therefore deflects the light to a horizontal plane or narrow zone.

Every thing about this light house is on a smaller scale, but sufficient for the purpose, since lights are frequently along this coast; and one more powerful would be of no superior advantage in clear weather, since this is now sufficiently strong for its height above the surface.

The above will give a full knowledge of the details of the lenticular system, and it is therefore considered unnecessary to dilate further on the subject.

Respectfully submitted:

B. Aycrigg, *Civil Engineer.*

Central Railroad.—In Thursday's *Daily* in alluding to the scite of the depot we remarked, that "we recollect that *five years* ago this was almost a barren spot," &c. If we had reflected one moment, we would have said *not three years ago*, &c., for we well recollect that the first spade was not struck in November, 1836, and in December of that year we were gratified with the commencement then made near the city. The rapid progress since made, speaks volumes for the energy of the President and Directors.

[*Georgian.*]

THE READING RAILROAD: ITS ADVANTAGES FOR THE CHEAP TRANSPORTATION OF COAL, AS COMPARED WITH THE SCHUYLKILL NAVIGATION AND LEHIGH CANAL. BY W. EDWARDS.

(Continued from page 159.)

READING RAILROAD.—NO. V.

In No. III. it was shown, that a boat costing $550 is capable of carrying on the Schuylkill navigation, from 55 to 57 tons of coal each trip, and would, were there no detentions other than the passing of the locks, be able to make twenty trips in the season of eight months, the time the canals are usually open; but owing to the occasional overflowings of the tow-paths by spring and fall freshets, and to the droughts of summer, the full average number of trips is seventeen, and the average load 54 14-20 tons, making in all an annual tonnage for each boat of 930 tons. Average time of each trip up and down, two weeks.

As a great increase in the number of trips has been asserted as possible, and a consequent diminution of the per ton cost, it will be well to examine how far it is practicable to increase them.

Each horse drawing the coal boats, is capable of working twelve hours on an average daily. In the pools, which are thirty-four in number, and in length 50 miles, his speed with a loaded boat is three miles per hour; in the canals, twenty-seven in number, and in length 58 miles, his speed is reduced [owing to the increased resistance from the water being confined by the canal banks] to two miles per hour, exclusive of delays in passing the locks and waiting the regular turn to pass. The delay at the locks is greatest with a large trade on the canal, and is estimated by persons engaged in boating as equal on an average to two minutes for each lock, besides the time required to pass the lock, which averages six minutes, being in all for each lock eight minutes.* Returning with empty boat, the speed in the pools is increased to 4 miles per hour, and in the canals to 3 miles per hour. The time required to pass from Fairmount to the coal wharves, to wait there till the tide suits, to unload and return to Fairmount, averages twelve hours, or one day. Delay at the coal landings at Pottsville in receiving cargo, &c., twelve hours, or one day. Total time for each trip, as follows:

Time at Pottsville receiving cargo, &c.,	-	12	hours, or	1	day.
Time descending through pools,	- -	17	"	1 1-2	"
Time descending through canals,	- -	29	"	9 1-2	"
Time ascending through canals,	- -	19	"	1 1-2	"
Time ascending through pools,	- -	13	"	1	"
Time in passing 234 locks, 8 minutes at each,		30	"	2 1-2	"
Time at Philadelphia unloading, &c.,	-	12	"	1	"
Total,		132	hours or	11	days.

It will thus be seen that at least eleven days are required to perform a trip, without accident to boat or detention from too much or too little water in the pools, and that it is not possible to accomplish it in less time, unless by increasing the number of horses and hands to manage the boat, and by running a greater number of hours per day, which would add to the cost fully equal to the increased speed, and even exceed it. This has been proved by experience.

The entire distance from Pottsville to the coal wharves on the Schuyl-

* The Lehigh navigation company, in the last report, say, "the total interruption or detention at each lock, may average six minutes, or 12 minutes going both ways which would be 10 3-4 hours for 44 locks."

kill, and returning to Pottsville per the Schuylkill navigation, is 216 miles, and is performed in six and a half days, [exclusive of one day's delay at Pottsville in loading, &c., one day's delay at Philadelphia unloading, &c., and two and a half day's detention in passing 234 locks],—say six days and a half of twelve hours each, or seventy-eight hours, which gives an average speed for each horse of two and three quarter miles per hour, and the number of trips being seventeen in the season, gives a total distance travelled by each horse of 3,672 miles. If the boatmen attempt to push the horse beyond this speed, the animal is over worked and injured; besides, the men engaged in navigating the boat are not able to work more than twelve hours daily.

The speed for the train engines to be used in drawing the coal cars on the Reading railway, will be about 8 miles per hour, or about three times that of the horses on the canal. The distance from Pottsville to the coal wharves of the company on the Delaware, being 94 miles, the time required to perform it will be one night of twelve hours, and the engine will remain at Philadelphia during the whole day for examination and repairs [when necessary], and return with the empty cars during the next night of twelve hours to Pottsville; the cars being in the mean time or during the day, unloaded directly into the vessels from the company's wharves on the Delaware. During the next day the engine will remain at Pottsville for examination and repairs, and the cars will be loaded during the day, and be ready to return to Philadelphia the same evening. By this arrangement, it will be perceived that the cars are either at Pottsville during the day or twelve hours being loaded; or at Philadelphia during the day or twelve hours being unloaded; and also that the engines are during the whole of each day at either end for examination and repairs [when necessary.]

Thus one half the number of cars will carry the same amount of tonnage that could be done by loading them during the day time, and bringing them down the next day, and unloading them the day after, and taking them back on the fourth day, or in all for each trip four days; whereas by the above arrangement, two days and nights will be sufficient for each trip. It is true, there will be an additional expense for wages, &c., running at night; but this will be more than counterbalanced by each engine and car performing a trip up and down in two days and nights, instead of four days.

To bring from Pottsville to this City, 930,000 tons of coal, by the Schuylkill navigation, would require (each boat being capable of bringing 930 tons in the season) one thousand boats, one thousand captains, one thousand men, one thousand boys, and one thousand horses. The total working capital would be

First cost of 1000 boats at $550 each, - -	$559,000
" " 1000 boats' furniture, at $25 each, -	25,000
" " 1000 horses, at $80 each, - -	80,000
Six hundred and fifty-five thousand dollars	$655 000

Total cost of running each boat per season, as shown in No. III., is $1,082,22 which for 1000 boats is $1,082,220

One million and eighty-two thousand, two hundred and twenty dollars.

To bring from Pottsville to this city, 930 000 tons of coal by the Reading railroad, would require 31 engines [of Wm. Norris' class B. of engines of equal power, each engine drawing in the year, 30,000 tons,] 31 engineers, 31 firemen, and 155 men to attend the trains—5 men to each train,

And should 4 ton cars be adopted by the company (each car performing 125 trips annually, would bring 500 tons) it would require 1860 cars.

The total working capital would be

The first cost of 31 locomotive engines, at $8000 each,	$248,000
First cost of 1860 cars, at $258 each, - -	465,000
Seven hundred and thirteen thousand dollars.	$713,000
Total cost of running each engine *per annum*, is $5000, which for 31 engines is - - - -	$155,000
Total cost of running each *per annum*, is $105 50, which for 1860 cars is - - - - -	196,230
	$351,230
Total cost of freighting, per Schuylkill navigation, 930,000 tons is $1,082,220, or per ton - - -	$1 16 1-2
Total cost of freighting per Reading railroad, 930,000 tons is $351,230, or per ton, - - -	0 37 3-4

Thus it appears, that should the company use coal cars capable of carrying 4 tons each, and the engines be able to make 150 trips annually, the cost of freighting will be reduced from 51 3-4 cents, as estimated in No. III., to 37 1-2 cents per ton.

READING RAILROAD NO. VI.

By referring to No. III., it will be seen that the expenses on each ton of coal, per the Schuylkill navigation, from the landings at Pottsville to the hold of the vessel in the Schuylkill, are $3 23 1-2 cents.

The Lehigh coal and navigation company are at present able to bring their coal from their mines and discharge it into the vessel from their landing at Bristol for about 65 1-2 cents per ton less than the coal dealers on the Schuylkill, and have consequently driven out of the market almost all the dealers in white ash coal. Those engaged in mining and bringing to market red ash coal, have been enabled to continue their business, mainly from the fact, that red ash coal is peculiar to the Schuylkill coal region, and commands in the eastern markets a price beyond that of the white ash coal. When, therefore, the Lehigh company shall succeed in obtaining the law for an outlet lock at Black's Eddy [as sooner or later they may,] they will be enabled to transport coal to New York from 40 to 50 cents per ton less than they do at present, or from $1 05 to $1 151-2 per ton less than by the Schuylkill navigation.

If to the costs per Schuylkill canal, $3 23 1-2 we add $1 25 freight from this city to New York, it gives a total cost of $4 58 1-2 per ton. By the Lehigh Canal the total expenses from their mines to New York is about $3 93 per ton: but with an outlet lock at Black's Eddy, this would be reduced say 50 cents, or to $3 43 per ton.

The Lehigh company have, therefore, a present advantage over the Schuylkill navigation company of 65 1-2 cents per ton, with a further prospective one, of from 40 to 50 cents, or in all from $1 05 1-2 to $1 15 1-2 per ton.

The whole toll on the Schuylkill navigation being but 92 cents per ton, it is evident that some other and cheaper means of conveying our anthracite to market, must be resorted to, in order to prevent the great evil of a diversion of the coal trade from our city. In this view, the Reading railroad becomes a matter of just pride to every cttizen of Pennsylvania interested in her growing prosperity, and to the citizens of Philadelphia, especially, it is a matter of deep interest. Who has not looked with pride upon

the hundreds of vessels in our river, receiving their cargoes of coal? And who would not arrest the hand that would attempt to divert this trade from our city? The deep interest felt in this community was recently shown by the numerous and respectably signed petitions that filled the desks of our representatives at Harrisburg, protesting in strong language against the passing of any law allowing the diversions of the coal trade from Philadelphia.

The inability of the Schuylkill navigation company to retain the trade is manifest; and the vast importance of that trade, and the large increase of it to be looked for, invest with peculiar interest the examinations that have been made, in regard to the ability of the Reading railroad to transport coal cheaper than either Lehigh canal or Schuylkill navigation companies.

That a cheaper means of conveyance than the present is required to continue the coal trade at Philadelphia, is no longer a question among practical men, or those who have examined the subject.

Such a means the Reading railroad presents to them. Though some may affect to doubt its entire success, yet the question of railroad transportation is now so well understood in Europe and in this country, that it is no longer a matter of theory. The Reading railroad, with its unparalleled favorable grades, has the power of transporting at the minimum cost of railroad transportation; and as the trade will be uniform, the engines having full and constant work, while the fuel will be obtained at the lowest price from the mines, it follows that all that can be accomplished by locomotive power may be safely looked for from the engines on this road; and the estimate of the cost of transportation, made in No. III., may be referred to as matters not of theory, but as results drawn from experience on other roads, both here and in Europe.

It was there shown that the cost for motive power on the Reading railroad, is per ton, - - -	$0 23 1-2
For use of cars, - - - - - -	0 28 1-4
For increased care in screening coal at mines, per ton,	0 12
For discharging coal from cars into vessels, &c., -	0 15
	0 78 3-4
To which add for toll, 1-2 cent per ton per mile, 94 miles,	0 47
And for freight to New York, - - - -	1 25
	$2 50 3-4

TOTAL EXPENSES FROM THE MINES TO NEW YORK PER READING RAILROAD, TWO DOLLARS AND FIFTY CENTS AND THREE QUARTERS.

The Reading railway, therefore, possesses the power of transporting coal to New York 92 1-4 cents per ton less than the Lehigh company, even with the outlet lock at Black's Eddy, allowing the railroad 1-2 cent per ton per mile for toll. But in a close competition, the Reading railroad company could omit all charge for toll, inasmuch as they have a business, the profit on which, from passengers, merchandize, and the United States Mail, as estimated by Messrs. Moncure and Wirt Robinson, the engineers of the road, amounts to $437,655 *per annum*, while the total expenses of the road are estimated at $153,200, leaving $284,455; whereof $100,000 is required to pay interest on loans, $2,000,000, at 5 per cent., and the balance $184,445 divided amongst the stockholders, gives on the capital of $2,000,000, an annual dividend of 9 1-4 per cent.

The Reading railroad company could therefore come into the market

prepared to carry coal *without any road charge*, and the respectiv e a ilities of the two companies would then stand thus :

Cost per ton from the Lehigh mines to New York, per Lehigh railroad and canal, State canal, Black's Eddy outlet, and Delaware and Raritan canal, to New Brunswick, and thence to New York, - - - -	$ 3 43
Cost per ton from Pottsville to New York, per Reading railroad to the Delaware, thence by sea or by the Delaware and Raritan canal, &c., to New York. - -	2 03 3-4
	$ 1 39 1-4

Difference in favor of Reading railway [excluding toll on coal,] one dollar thirty-nine cents and a quarter.

As, however, the Lehigh company's valuable coal lands adjoin the Little Schuylkill railroad at Tamaqua, about 20 miles above Port Clinton [and at Port Clinton the Little Schuylkill railroad will be connected with the Reading railroad] and the distance from Port Clinton to Philadelphia is 79 miles, their coal will be within 5 miles as near to this city as that from the Pottsville region. It will therefore be manifestly their interest as coal owners, to open their mines at Tamaqua, whence by the above route their coal would descend 20 miles over the Little Schuylkill railroad to Port Clinton, and thence 79 miles over the Reading railroad [in all 99 miles] to Philadelphia.

Should the Lehigh Company succeed in selling their canal to the State which they have endeavored to do, this would then be to them a most unobjectionable means of transporting their coal to a market.

(To be continued.)

The Central Railroad.—This great work is progressing rapidly. The cars now run eighty miles and five miles farther are completed. Already is the attention of the people in this section turning towards it, as the best and most expeditious mode of getting their crop of the present year to market. It must be borne in mind that we are sixty miles from the present terminus.

Whatever prejudices may have existed against this enterprise are rapidly disappearing: and as it approaches to our immediate neighborhood, its benefits are not only theoretically but practically exhibited. The fact is, the next legislature must be liberal in the course pursued to the central railroad, without doubt the most beneficial, as well as extensive undertaking of the kind now in progress in Georgia.

We anticipate with delight the time when we shall be able to visit Savannah, without the long and tedious journey we have so often undergone. Let us speak a word of advice to old Chatham, which, if not the land of our birth, was for many years our happy home, endeared to us by a thousand remeniscences of childhood, of joys departed, which in this world can be felt no more, and of treasured friends now separated never to be united again. But to the point, you have five members allowed you to the next legislature, we are happy to see our friends, whether Union or State rights, but a nature is preferable at present, as the Union party have the power, we cannot expect them to allow the State rights party the majority, but you can very well give us two, which would be an instance of generosity seldom met with, and therefore the more creditable. It is the interest of Chatham to pursue this course, send men, however divided in politics, who will unite for the interest of the railroad, and it will be a great step taken in accomplishing your favorite object.—*Sandersville Advocate.*

HORTICULTURE.—The Horticultural Society of the valley of the Hudson, held a meeting recently, at the saloon in Niblo's garden. The display of plums, peaches, nectarines, mellons, filberts, grapes, etc., were the most choice and inviting we have ever seen. The exhibit of flowers, particularly of Dahlias, truly gorgeous, and the show of vegetables fine. Among the latter a squash, 184 lbs., from Fishkill.

The contributors were not numerous. New York and Brooklyn, Messrs. Prime, Hogg, Perry, and others; Mr. Downing and others of Newburgh; Mesers. Holbrook, Kneeland and others, of Hyde Park; Mrs. Stephen Van Rensselaer, Buel, Denison, and others of Albany; A. P. Heartt of Troy, etc., etc.

The address, by *William Emmerson, Esq.*, a highly finished performance.

The subject of this paragraph does not fitly belong to our Magazine, or we would enter more in detail on this truly facinating science, that may be said, assists nature to improve her own productions. We cannot, however pass the gardners' *Coat of Arms*, a pretty fancy, quite out of the common order, partaking so much of mechanical nicety, that we give the following from the Commercial Advertiser. A drawing of the *coat* of *arms* ought to be taken and fully placed before the readers of our rural publications; but to our extract.

"The gentleman whose contributions are the most extensive and various, is Alexander Walsh, Esq., of Lansingburgh. And to his taste the society is indebted for a very appropriate and beautiful ornament, at the head of the saloon. It is what Mr. W. has fitly named the horticulturist's coat of arms, forming a pyramid, twenty-four feet high, constructed entirely of the various instruments of horticulture. A thermometer, handsomely decorated, is placed in the centre with the motto, "SCIENCE DIRECTS OUR MOVEMENTS." The spade, rake, hoe, &c., &c., covered with a wreath of evergreens, and decorated with a superb variety of dahlias, rare exotics, and native flowers, form the frame work of this fanciful device. From the most prominent parts of the structure are suspended filberts, teazle, madder-root, woad, sumac, perennial flax, &c., all produced by Mr. Walsh, emblematic of the aid horticulture affords to manufactures. The silk business is fully represented by the eggs, reeled silk, and a tasteful display of cocoons and wreaths of the silk moth. Near the centre of the structure, the grape, and that which maketh the heart glad, corn, oil, and wine, are justly represented.

The pedestal, some thirty feet long, is loaded with some fifteen or twenty varieties of plums, also apples, pears, filberts, a profusion of choice and rare vegetables, and we may here also mention, a diminutive bee hive, and a sun-dial.

On the right, a little raised from the pedestal, are placed a variety of rural engravings. Copies of the New York, New England, Michigan, and Genesee Farmer, the Cultivator, and other publications, fully to complete this gardener's budget, have likewise been placed upon the table—Mr. Walsh's motto being—

"Son utile ainda que bricondo."

"I am useful even when sportive."

Table of the mean temperature of each of the months for the years of 1833, 1834, 1835, 1836, 1837, and 1838. Also the day the thermometer was at the *extreme* lowest and highest; and the number of days that was clear, cloudy, rainy, white frost, foggy morning, snow, hail, or sleet, in each month. From the meteorological record kept at Avoylle Ferry, on Red river, Louisiana. Lat. 31° 10″ north, lon. 91° 59″ west, nearly. By P. G. Voorhies.

(Concluded from page 160.)

Date.		Mean temp. of months. Morn	Noon	Night	of the m'nth	Thermometer, the extreme in each month. Day.		low'st	Date.		high't	Number of days in each month that was either Clear	Cl'dy	Rainy	white frost.	foggy morn.	Snow	hail or sleet
June	1833	73	85	79	79	June	25th	64	June	30th	90	25	5	5				
	1834	72	87	81	80	"	12	68	"	30	90	21	9	6				
	1835	73	84	79	79	"	3	70	"	29	88	19	11	11				
	1836	71	85	79	78	"	5	62	"	9	90	19	11	5				
	1837	72	84	83	79	"	22	59	"	2	91	21	9	6				
	1838	76	86	79	80	"	4	72	"	25	94	30						
July	1833	73	88	80	80	July	5th	67	July	29th	93	28	3	3				
	1834	73	87	80	80	"	14	70	"	4	91	20	11	7				
	1835	72	82	[illegible]	77	"	3	61	"	29	89	15	16	14				
	1836	75	87	81	81	"	21	64	"	23	93	20	11	5		1		
	1837	74	87	81	81	"	1	73	"	15	89	25	6	6		1		
	1838	75	86	79	80	"	4	72	"	1	90	19	12	12				
August	1833	73	88	82	81	August	18th	67	August	5th	92	22	9	3				
	1834	75	86	81	81	"	31	67	"	20	92	18	13	8				
	1835	73	83	79	79	"	27	67	"	20	89	14	17	13				
	1836	74	86	79	80	"	22	66	"	8	90	19	12	10				
	1837	73	85	82	80	"	15	68	"	8	90	25	6	3				
	1838	72	86	80	80	"	24	68	"	14	90	23	8	7				
Septemb'r	1833	71	84	79	78	Septemb'r	23d	58	Septemb'r	1st	88	18	12	6				
	1834	66	77	73	72	"	8	54	"	2	88	17	13	13				
	1835	66	78	74	72	"	24	60	"	6	86	24	6	2				
	1836	71	83	76	76	"	30	62	"	3	86	12	18	15				
	1837	70	80	74	74	"	19	56	"	9	88	14	16	10				
	1838	64	79	76	73	"	24	41	"	8	87	26	4	3		1		
October	1833	53	69	63	62	October	22d	33	October	16th	85	24	7	5				
	1834	60	75	71	69	"	20	37	"	30	88	18	13	5	2			
	1835	59	73	66	66	"	9	46	"	2	82	21	10	5		2		
	1836	54	67	62	61	"	21	41	"	1	80	20	11	4	2	1		
	1837	61	70	69	67	"	25	34	"	1	82	17	14	4	1	3		
	1838	60	70	66	66	"	30	40	"	15	86	25	6	6		1		
Novemb'r	1833	46	65	59	57	Novemb'r	26th	25	Novemb'r	11th	78	22	8	5	7			
	1834	52	67	68	61	"	27	28	"	6	82	24	6	5	3	1		
	1835	51	62	58	57	"	29	32	"	19	79	13	17	10	2	2		
	1836	39	56	53	49	"	30	28	"	2	64	28	2	1	7	1		
	1837	54	67	66	62	"	23	31	"	11	84	20	10	2	4	3		
	1838	44	57	53	51	"	19	28	"	6	74	16	14	6	6	1		
Decemb'r	1833	46	58	55	53	Decemb'r	26th	29	Decemb'r	1	68	14	17	5	6	3		
	1834	45	60	56	54	"	27	31	"	1	75	15	16	8	7	1		1
	1835	46	62	58	55	"	23	32	"	19	74	17	14	5	7	1		
	1836	42	55	51	49	"	21	19	"	24	76	19	12	4	9	1		1
	1837	46	55	52	51	"	11	29	"	16	74	18	13	4	6			
	1838	40	51	47	46	"	24	21	"	2	63	14	17	5	14	1		

Harlem Railroad.—The receipts on this road for the month ending yesterday, are as follows, viz:

Sept. 1st to Oct. 1st, 1839,	$12,881 48
Sept. 1st to Oct 1st, 1838,	8,770 80

showing an increase the last month over the corresponding month of last year of $4110 68, equal to 47 per cent.

The number of psssengers conveyed on the road were one hundred and twenty-eight thousand three hundred and twenty-seven, including the passage both ways—being at the rate of one million five hundred and thirty-nine thousand and twenty-four passengers per annum.

The number of passengers taken on the road, who paid six-pence only, were seventy-six thousand one hundred and twenty-nine.